ESTIMATING THE GROUNDWATER RESOURCE OF THE UPPER OCONEE RIVER BASIN

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Abstract. Asked for an estimate of the groundwater resource of the Upper Oconee River Basin, Exploration Resources developed a proven resource estimate of 41.4 mgd and a probable resource estimate of 58 mgd from groundwater in the four-county study area. Existing groundwater wells were used to develop these estimates.

INTRODUCTION

Planners and governments in the Piedmont of Georgia are developing long-range plans for providing water. This planning requires a quantitative estimate of the groundwater resource which could be developed and the costs associated with developing this resource. The purpose of this paper is to discuss one approach to developing groundwater resource estimates.

BACKGROUND

In 1987, the Upper Oconee Basin Group (the Basin Group) was formed under the auspices of the Northeast Georgia Regional Development Center to choose among water supply alternatives for Barrow, Clarke, Jackson, and Oconee counties.

In 1991, the Basin Group completed a Water Supply Management Plan (Northeast Georgia Regional Development Center, 1991). The plan examined water needs, supply alternatives, costs, and environmental impacts for Barrow, Clarke, Jackson, and Oconee counties. Water use in 1980 was stated at 8 mgd from groundwater and 26 mgd from surface water in the four counties. The surface water sources are rivers or small reservoirs, both of which have limited yield during drought periods.

The Water Supply Management Plan estimated that 52.5 mgd will be required by the year 2050 in the four-county area. This estimate included an anticipated decrease in demand because of water conservation. The study estimated that by about the year 2005, peak water demands will exceed historic supply, even with water conservation. The study concluded that to obtain significantly larger quantities of water from surface water, additional sources of supply or reservoir storage will be required.

The U.S. Geologic Survey (USGS) made a general analysis for the Corps of Engineers (Radtke et al, 1986) of the occurrence and availability of groundwater in the region. The Water Supply Management Plan used this as a basis for estimating the contribution to be expected from groundwater.

For its water management planning, the Basin Group needed to know the contribution that can be reasonably expected from groundwater sources, the favorable areas for development of such supplies, and the estimated cost of developing the supply. The Basin Group decided that a well or well field capable of producing less than 200 gpm would not be suitable for use in the water systems of the area. Exploration Resources was retained to develop these estimates. The amount of money available for this project was strictly limited.

METHODOLOGY

This study developed estimates of the proven and probable groundwater resource and cost elements for developing the resource. The proven resource is based on the current capacity of existing wells and expected production from a limited number of new wells near existing well fields along known water-producing features. The proven resource provides the planners with the minimum guaranteed production available from groundwater.

Information on existing wells was entered into a database by combining the information gathered by the USGS for its 1986 study with new information collected from well drillers, who maintained the records primarily to facilitate later maintenance of the wells. We developed a form as a tool for gathering the information items of interest. However, it was found that drillers' records generally contained only the well owner's name, the depth of the well, the length of casing installed, well capacity, and installation date. For this study, well locations were determined by having the drillers identify the locations on maps. In several cases, drillers who have worked in the area have died or have moved away, and there is no way to locate their wells. We found that several of the major drillers in the area were not included in the USGS study.

Wells were included in the study if they were drilled wells and produced at least 20 gpm. Bored wells drawing water directly from the saprolite were not considered because they would be inappropriate as public water supply wells.

Computerized base maps of the study area were created by using TIGER files from the USGS. The base maps included political boundaries, hydrology, roads, railroads, and 7.5" quadrangle boundaries. There are no detailed geological studies of the study area; therefore, the geology from the Geologic Map of Georgia (Georgia Geological Survey, 1976) was added to the base map.

Well fields were defined as areas which within one mile diameter had more than 200 gpm from wells, each of which has a capacity of greater than 20 gpm. The one-mile diameter was chosen as the maximum distance considered practical to pipe water from individual wells to a central point for treatment. The 200 gpm was set by the Basin Group as the minimum quantity of water to consider as a resource.

The extent of well fields was calculated by generating a 1000 ft grid for the study area and calculating the total capacity of the wells within 0.5 mi of each grid node. The grid nodes were generated based on the Georgia West state plane grid, the same mapping units as the base map. A computer program was written which compared each of the 68,000 grid nodes to the well data base. Those grid nodes which had more than 200 gpm capacity in wells within 0.5 mi were added to the base map as 1 mi circles. The extent of the well fields were drawn on the maps as the outside edges of overlapping circles (Figure 1).

The computer program which determined whether grid nodes were within well fields also marked the well records to indicate whether they were within fields. Symbols for each well and its capacity were added to the maps, with one symbol for wells within well fields and another symbol those outside of fields. The total capacity of each well field was calculated by adding the capacities of the wells within the field. Within the study area, 41.4 mgd of proven capacity was identified from existing wells in well fields.

Probable Groundwater Resource. A significant number of existing wells remain unidentified because Exploration Resources was unable to obtain data from several drillers. Based on the success of other drillers in

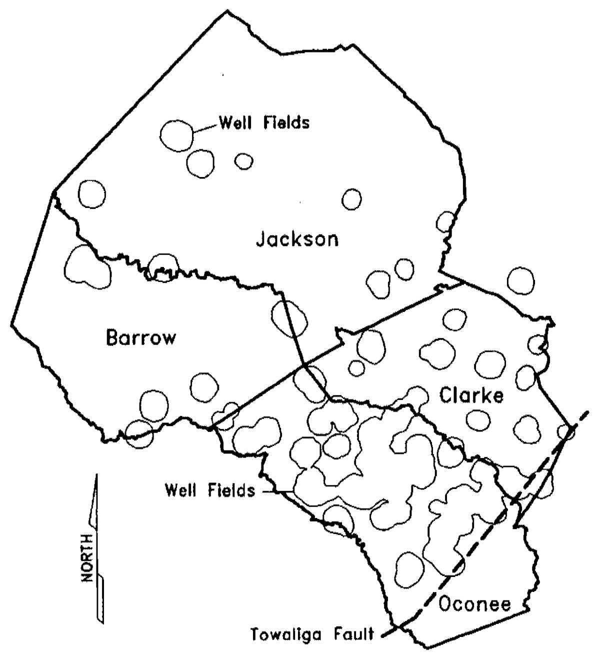

Figure 1. The study area, the well fields identified, and the Towaliga Fault.

the regions, we estimate that these drillers installed 400 wells with greater than 20 gpm capacities in the study area. We estimate that the average capacity of these wells is 50 gpm and that 60% of the wells would be within well fields. These wells would contribute 17 mgd to our reserve estimate. We estimate the probable reserve for the area at 58 mgd.

We examined the results of groundwater exploration programs undertaken by the Georgia Geological Survey in the Piedmont between 1987 and 1991. In 17 of 20 cases, the water needs of the municipalities were met. In three cases the projects were unsuccessful. We conclude that most groundwater development projects for small municipalities in the Piedmont are successful. We hoped to use the success of these project to develop probable groundwater resource estimates. Unfortunately, the information collected cannot be used in this manner because most of the projects were completed without attempting to maximize the potential production of the area.

Cost Estimates. We estimated that it would cost $450,750 to develop each one-mgd portion of the groundwater resource. This estimate assumed that 10 production wells averaging 90 gpm would be installed. The wells would average 300 ft deep with 65 ft of casing. An estimated additional 10 wells would be drilled which would not produce adequately. Each production well would have 1000 ft of gravel road, power, and mains built to it. Our estimates did not include water treatment.

In order to validate the estimated costs, we contacted utilities departments of two local governments which had recently acquired or developed groundwater systems. Their costs were approximately $210,000 and $700,000 for each one mgd developed. These costs approximate our estimate.

Classification of Areas for Groundwater Development Potential. Areas of the four-county region were classified for additional groundwater development potential based on the locations of the following features: existing well fields; known and probable water-producing geologic features (such as contact zones, shear zones, and anisotropic, easily weathered rock types); massive intrusive rock types thought to lack extensive shearing and fracturing (thus poorly transmissive to groundwater); and lineament orientation. Results are shown on Figure 2.

There are no detailed geological studies of the study area; therefore, the geology from the 1:500,000 scale Geologic Map of Georgia (Georgia Geological Survey, 1976) was digitized and added to the base map.

On Figure 2, areas are classified as those favorable for additional groundwater development; those less favorable for groundwater development; and those lacking sufficient well data for classification. These classifications are useful for planning and development purposes but are not quantitatively based on detailed data. Also, the classifications will not remain static in time. The boundaries of the more favorable, less favorable, and unclassified areas will change with future detailed local geologic mapping and the incorporation of additional well data from existing and new wells.

Lineaments. We examined maps and aerial photographs to identify lineaments in the four-county area. These lineaments were digitized and incorporated into the regional map. The orientations and densities of lineaments located in this study appear to be related to underlying geologic structure only on a case-by-case basis. Areas of greater topographic relief, such as northern Jackson County, tend to have higher lineament densities and to show preferred orientation perpendicular to and parallel to regional geologic strike. Regions of lower topographic relief, such as south-central Oconee County, tend to have lower lineament densities and more apparently random orientations.

In at least one case, along the Towaliga Fault shear zone in south Oconee County (geology map), certain lineaments are oriented parallel (southwest-northeast) to the fault orientation. This shear zone yields abundant groundwater, as seen by the density and orientation of well fields in south Oconee County.

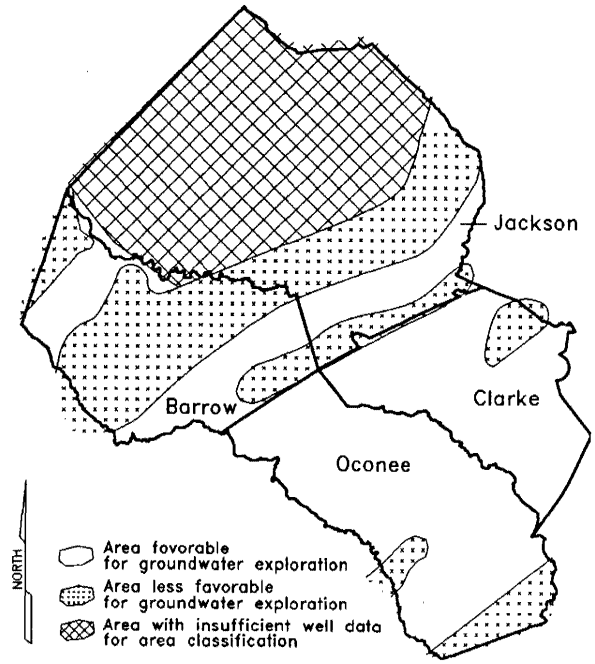

Figure 2. Classification of the study area for groundwater development favorability.

DISCUSSION

Using high capacity wells to delineate well fields and estimate the available groundwater resource is effective but has limitations. In areas where information can be gathered on at least 10 wells per square mile, clear patterns of high production wells result. In areas which are sparsely populated, there may be an insufficient number of wells to provide the necessary information. Drillers tend to work predominantly within a few counties, so if information is unavailable from a driller who has worked in an area for several years, the area will be under-represented by known wells.

We cannot expect every well in every well field to produce continuously at capacity. However, more wells could be drilled to increase the capacities of the well fields identified. Considering both of these factors, the derived capacities of the well fields are realistic estimates for proven reserves.

RECOMMENDATION

Local or state government should create a database of existing wells. This information is important for groundwater resource estimation, groundwater exploration, wellhead protection, and proper siting of facilities with the potential to adversely impact groundwater quality. Information for new wells could be collected by requiring building permits and inspections for wells. Complete information on existing wells could be gathered by contacting the users of the wells.

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